FLAX

in

WESTERN CANADA

VARIETIES
PRODUCTION
HARVESTING
& THRESHING
GRADING

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ALTHOUGH THE PURPOSE OF THIS BULLETIN IS TO OFFER SOME GUIDANCE WITH RESPECT TO THE GROWING AND HARVESTING OF FLAX IN WESTERN CANADA, NO ACCOUNT OF THIS IMPORTANT CROP WOULD BE COMPLETE WITHOUT A BRIEF REFERENCE TO PRODUCTION TRENDS AS WELL AS TO THE CHANGING USES TO WHICH VARIOUS OIL SEED CROPS ARE BEING PUT AND THE GENERAL OUTLOOK FOR FLAX AND LINSEED OIL.

Trends in Flax Production

Because of its adaptability to varied climatic conditions, the flax **seed** crop has a much wider range than that grown for **fibre.** Yet, although flaxseed is produced in a number of countries in many parts of the world, it is raised extensively in only a few. Thus between them, in 1957, the **U.S.A., Canada, Argentina** and **India,** produced 70% of the world's flaxseed. World production has shown considerable fluctuation from year to year but there is no significant trend, foreign production and overall consumption showing little tendency to expand.

THE CHANGING PRODUCTION PATTERN

The following table shows the world production of flaxseed for each of the past two seasons, as well as the average production for the 5-year pre-war period, 1935 to 1939, and, in the case of the major producing countries, the average production for the most recent 10-year period 1948 to 1957.

World Flaxseed Production in Bushels

	Five Year Average, 1935-39	1956	1957	Ten Year Average 1948-57
United States	10,991,000	48,009,000	25,754,000	39,680,000
Argentina	59,571,000	24,408,000	23,818,000	19,370,000
Canada	1,508,000	34,463,000	19,979,000	14,000,000
India	19,360,000	16,560,000	13,960,000	15,104,000
Others	43,340,000	44,300,000	41,139,000	Not available
Total	134,770,000	167,740,000	124,650,000	Not available

Source: U.S. Department of Agriculture & The Grain Trade Year Book.

The above figures indicate very clearly the marked change in the production pattern that has come about since the late thirties. During the 40 year period 1908 to 1948, the UNITED STATES had imported flaxseed and during that time she had brought in just about as much as her own farmers had raised. During the 1930's, in fact, imports ran higher than production. Based on needs and experiences during World War II, a drive made to increase domestic production culminated in a record 1948 crop of close to 55 million bushels. For the past 10 years, annual U.S. outturn has continued at a high level averaging close to 40 million bushels or some 10 million bushels above domestic requirements. Dramatically, therefore, the United States has changed over from being the world's leading importer of flaxseed to a major exporter of this commodity.

CANADA'S performance has been almost as striking. During the immediate pre-war years the flax crop totalled about 1½ million bushels and the difference between this and Canada's domestic requirements was made up by imports of flaxseed principally from Argentina, although varying quantities of linseed oil were also imported. During the war, with the oil situation becoming acute, price inducements were given, acreage and production were increased and the crushing capacity of Canadian mills was expanded. There have been some fairly wide variations in Canadian acreage and production since 1940 but flax has now become an important crop in an expanding economy and, in recent years Canada's exports have been significant. As will be seen from the above table, the average production for the past 10 years has been 14 million bushels, an all-time record crop of 34.5 million bushels having been produced in 1957 on some 3½ million acres. Against this level of production domestic disappearance in Canada during the past few years has averaged about 8 million bushels, leaving the balance available for export.

ARGENTINA, formerly a major producer of flax, with production between 1930 and 1939 averaging nearly 67 million bushels annually, has witnessed a large decrease in production, with the average for the past 10 years being close to 20 million bushels. However, this country is now encouraging an expansion in the acreage and production of flaxseed and, had earlier prospects been maintained, during the past season Argentina would have harvested its largest crop in 9 years.

Most of the demand for flaxseed has come from Europe, some 89% of world imports from 1952 to 1956, being made by Continental countries. Moreover, since European buyers prefer to do their own crushing rather than to purchase the oil, a substantial portion of the exports made from Canada and the U.S.A. have been in the form of flaxseed. In a recent year, for instance, Canada crushed 3.6 million bushels of flaxseed with an oil recovery of 72 million pounds. Of this, only 15 million pounds was exported. Canada's share of total flax exports has varied but it has increased during the past 3 years and, in 1957, it represented about 30% of the total world movement.

Flax in Competition With Other Oil Seed Crops

Until quite recently flax was the chief source of oil for paints and for numerous other industrial uses. However, during the last 10 years, while the domestic consumption of paints in Canada and the U.S.A. has increased tremendously, the consumption of linseed oil has remained practically unchanged. Overseas, a similar situation exists. Here there has been a considerable expansion in paints, linoleums and other drying oil uses but most of it has taken place without a corresponding increase in the use of linseed oil. Synthetic materials and other vegetable oils have now come into direct competition with linseed and this form of competition may increase. This does not mean that linseed oil will be entirely replaced, particularly in the case of outside paints where it is still supreme as an oil that withstands the elements.

However, it does have certain disadvantages including a readiness to oxidize or turn yellow on exposed surfaces and pricewise, too, it has had to give way to cheaper oils where these could be substituted.

In this connection, observers close to the situation suggest that, other things being equal, the raw materials used for paints will be those which are cheapest and in ready supply. They believe that linseed oil will be used for a number of years yet as a raw product for paints, varnishes and linoleums but point out that it will have to be considered as a basic raw material which will have to compete with other basic raw materials on a pound for pound basis. From the producer's standpoint, too, flaxseed must compete with other cash crops and be equivalent in dollar returns per acre.

This, then, is broadly the situation today with respect to flaxseed and its product, linseed oil. Undoubtedly, as research continues, wider uses will be found for linseed oil and some of the objections to it may be overcome. Other approaches which will tend to bring flax more in line with competing oil seed crops will be further increases in quality and yield and a lowering of production costs.

Flax as a Crop

Until recent years, flax was regarded in Western Canada more in the nature of a 'special' crop, rather difficult to grow and inclined to be hard on the land. More often than not, it was only grown if conditions or prices happened to be favorable or if something had occurred to prevent the planting of one of the major cereals. Many of the objections to flax, however, have disappeared and with the impetus given this crop both during and subsequent to World War II, plus the greatly improved variety picture, flax now enjoys a much higher standing among farm crops and it is being grown today with a good deal more assurance and success than formerly.

The plant itself is shallow rooted and rather drouth susceptible, competing poorly with weeds and favoring a relatively cool growing season in its early stages of development. For these and other reasons, it possibly demands a higher priority in timing and in the sequence of operations than other cereal grains, including wheat.

Unfortunately, too many producers are still inclined to consider flax as a crop that may be sown at the last minute in almost any kind of soil. This is a mistake since, under such conditions, returns are likely to be very disappointing. The idea, still quite commonly held, that flax is hard on the land, has not been substantiated. All experimental evidence to-date indicates that flax does not have a detrimental effect on the soil and that it removes less of the main nutrient elements such as nitrogen, phospherous and potassium than does either wheat or oats or barley. In the past, some of the disappointment with respect to flax and the crops that followed flax, undoubtedly stemmed from the weed problem and the fact that, until chemical spraying was possible, weeds were inclined to be more prevalent in this crop with resultant loss of moisture. Today, where good farming practices are followed, weeds are no longer a major problem and flax, vulnerable as it used to be, in this and certain other respects, is able to compete quite favorably with wheat and other cereals for a place in the cropping system on the average farm.

Flax Breeding

Although the main diseases of flax such as rust and wilt have been brought under control through the breeding of resistant varieties, a few diseases of flax are still of concern to the plant breeder. These include "pasmo" and "aster yellows" which will be referred to under "Diseases". In the case of "pasmo", plant breeders are working to build up resistance—a task which has presented some difficulties due to inability to find a variety with outright resistance to the disease. In the case of "aster yellows", the problem is either to breed towards resistance of the leaf hopper which transmits the disease or towards resistance of the virus itself.

With the main diseases under control, the plant breeder is now able to concentrate more upon other desirable factors in flax such as early maturity and yield, increase in seed size and particularly oil content and quality. New methods have been developed which enable the plant breeder to determine lines of high oil content in very early generations where the quantity of seed available is always limited. Other important considerations to which he is giving attention are iodine value, related to drying ability, and linolenic acid content. Undoubtedly as time goes on, advances which have already been made will enable the plant breeder to develop varieties of flax which will be more valuable to the commercial interests as well as to the farmer.

Varieties

At the present time, 6 varieties of flax account for practically all of the flaxseed acreage in Western Canada. A brief description of these varieties follows:

MARINE: A selection by the North Dakota Experiment Station from the cross CI 975 x Sheyenne and licensed for distribution in Canada in 1952. This variety, which carries blue flowers and a small to medium-sized seed, is almost as early as Redwing. It is of fair height and strength of straw and is resistant to wilt and rust as well as being fairly tolerant to pasmo. Marine has tended to replace Sheyenne and Redwing in northern areas of Manitoba and Saskatchewan where either early maturity or rust resistance are factors to be considered. The yield of this variety is generally somewhat below that of other leading varieties.

NORLAND (VICTORY): A new, more evenly maturing selection, made from the old strain Victory by the North Dakota Experiment Station, which has been increased and distributed in Canada by the University of Saskatchewan. This is a late, white-flowered variety with large brown seeds. It is of medium height and is immune to all races of rust, as well as being moderately resistant to wilt; it is, however, susceptible to pasmo. Oil content and quality of the seed is very good. The variety is subject to natural crossing and thus difficult to keep pure unless grown under strict isolation.

RAJA: Selected at the Cereal Division, Central Experimental Farm, Ottawa, from a cross of an Argentine selection. Raja is a blue flowered, early maturing variety with large brown seeds of average oil content. It is resistant to all forms of rust as well as to flax wilt but is susceptible to pasmo. While it matures a few days earlier than Marine, the yield of Raja is not as good when early seeding is practiced. For this reason it is found to be satisfactory for delayed seeding. In northern areas the variety does not appear to do as well as Redwing.

REDWING: An introduction from the Minnesota Experiment Station distributed in Canada in 1932. The flowers of this variety are bluish lavender in color and the seed reddish brown and very small. The plant is of medium height and the strength of straw good. The variety is only semi-resistant to flax wilt and rust and is susceptible to pasmo. The ability of Redwing to produce a good yield and to mature early has permitted this variety to remain on the recommended list for the northern areas where frost is frequently a hazard. It is grown mainly in northern Alberta but to some extent in northern Manitoba and Saskatchewan, as well.

REDWOOD: Selected at the Minnesota Experiment Station and distributed in Canada in the spring of 1951, Redwood is a blue flowered uniform ripening late maturing variety with straw of good height and strength. It is resistant to all forms of rust as well as to flax wilt and is fairly tolerant to pasmo. Oil content of this variety is high and of good quality. It is recommended in Manitoba for most of the areas south and west of Winnipeg and farther west it is recommended in all southern and central areas of Saskatchewan as well as for most of the south-eastern portion of Alberta. Where it is grown successfully, it has yielded well and somewhat above the other leading varieties.

ROCKET: Selected by the Cereal Division, Central Experimental Farm, Ottawa, from the cross Argentine 8C x Redwing and distributed in Canada in 1947, Rocket is a dark blue flowered variety with brown seed medium to large in size. It is medium to late but uniform in maturity, being a few days earlier than Redwood. It is resistant to rust, semi-resistant to wilt although somewhat susceptible to pasmo. Because of its intermediate maturity date, it is usually grown in an area somewhat north of that in which Redwood is recommended. Yield is moderately high.

GENERAL VARIETY RECOMMENDATIONS

(By Province)

In MANITOBA, **Redwood** is the leading variety in the southern and central flax growing areas with **Rocket** and **Norland** classed as "second choices". Of the earlier varieties, **Marine** being completely wilt and rust resistant, is recommended where delayed seeding is necessary in the south and where early maturity is needed in the north to escape frost. **Raja,** although earlier maturing than **Marine** and equally resistant to wilt and rust, does not appear too satisfactory in the northern areas of Manitoba where early seeding is necessary. It is, however, generally satisfactory for delayed seeding in other sections of the province.

In SASKATCHEWAN, the later maturing varieties **Norland, Redwood** and **Rocket,** seem to produce the best yields under most conditions and all three varieties are recommended in that province. If seeding is delayed until June, however, early maturing varieties such as **Marine** and **Raja** are preferable and satisfactory yields may often be obtained if they are sown as late as June 10th, or even a few days later. Of these, the first named, **Marine,** is gradually replacing **Redwing** because of its rust-resistance. The variety **Raja** has produced satisfactory crops of average height under conditions where later maturing types would almost certainly be frozen. When seeded at the normal time, however, **Raja** often does not perform as well, tending to be short and low in yield.

In ALBERTA, **Redwood** is recommended for most of the southeast portion of the province while **Rocket** is recommended for areas further north. **Norland** is still under test. Where earlier varieties are needed in extreme northern districts, **Redwing** is mainly grown, the variety **Marine** being still under test and **Raja** being not recommended as yet.

VARIETY YIELD PERFORMANCE

Rating Based on Comparative Tests
(1951 to 1956 Inclusive)

	Black Soil Zone (Manitoba & Sask.)	Brown Soil Zone (Sask. & Alberta)	Black & Grey Soil Zone (Alberta)	
1.	Redwood	*Norland	*Norland	1.
2.	*Norland	Redwood & Rocket	Rocket	2.
3.	Rocket	—	Redwood	3.
4.	Raja	Redwing	Redwing	4.
5.	Redwing	Marine	Raja	5.
6.	Marine	Raja	Marine	6.

* 5 Year average only

—Courtesy: Experimental Farms Service
Canada Department of Agriculture.

AVERAGE NUMBER OF DAYS TO MATURE

Based on Comparative Tests: Black Soil Zone, Manitoba and Saskatchewan
(1954 to 1956 inclusive)

Variety	No. of Days To Mature
Redwood	102.4
Norland	102.1
Rocket	101.3
Marine	97.0
Raja	95.3
Redwing	94.7

—Courtesy: Experimental Farms Service
Canada Department of Agriculture.

Seed and Seeding Practices

SEED

Because uniformity of ripening is important in flax, every care should be taken to see that only clean, sound, true-to-variety seed is sown. The only guartee of such quality and performance lies in the purchase of Registered or Certified seed and particularly where a producer is growing flax for the first time or after a lapse of some years, the purchase of this class of seed is strongly recommended. New varieties have both uniformity of maturity and disease resistance. This means that, given seed of the right type, some of the former hazards in the growing of flax have been eliminated. All flax intended for seed should, however, be tested for germination, although, here again, this step is automatically taken care of if Registered or Certified seed is purchased. It goes without saying that only seed of the variety best adapted to the district, should be sown.

SEED TREATMENT

All flax should be treated with a suitable fungicide since, quite apart from the protection it affords against soil and seed-borne diseases, seed treatment will improve emergence.

Flax threshed under dry conditions may have as high as 50% of the seeds showing minute fractures in their coats. Also present, but more difficult to detect, are minute ruptures on the seed coats along the edges of the seed. While flaxseed injured in this way may germinate quite well in the laboratory, as soon as the seeds are planted in ordinary soil, they are subject to attack by soil borne micro-organisms which impair germination. This is why, in the case of flax, it is so important to protect the seed with a fungicide.

Flax grown in moist areas is less likely to show seed fractures although the seeds may carry seedling blight fungi which attack the seedlings at both the pre-emergent and post-emergent stages of growth.

The general practice is to treat seed with an organic mercury compound such as Ceresan, Leytosan or Panogen at the prescribed rates, efficiency of treatment depending on good coverage of the seed. Normally, seed is treated just prior to seeding operations although if conditions for storage are good and moisture content is normal, it may at times be treated several weeks ahead.

DATE OF SEEDING

In any given season there appears to be a definite time limit beyond which flax should not be seeded. Beyond that limit, the chance of producing a profitable crop is something of a gamble. All evidence seems to point to the fact that flax is more often planted too late rather than too early in the season. The goal, therefore, should be to seed flax as early as possible taking such factors into account as the condition of the land, the weed situation, available moisture, and the variety to be seeded.

Contrary to popular belief, flax seedlings fairly soon after emergence stand freezing about as well as small grains, and under favorable condition flax 2 to 3 inches in height has survived temperatures of 18°F. without injury. Once established, the crop thrives in cool weather and gets a head start on weeds. Thus early planting usually permits flax to complete most of its development in favorable weather before the extreme heat of July and August. Very important, too, is the fact that flax seeded early is less likely to be affected by disease and if it is affected, the injury will not be as severe.

Some interesting data which shows the importance of planting flax relatively early in the season is given below:

YIELD OF FLAX UNDER DIFFERENT DATES OF SOWING AT WINNIPEG*

DATE OF SOWING

VARIETY	1948 May 12	May 21	May 29
Rocket	32.01	24.74	10.24
Sheyenne	25.26	25.62	16.58

	1949 May 12	May 21	June 2
Rocket	19.75	19.38	11.54
1/Victory	18.81	20.27	13.77
Sheyenne	15.64	16.79	12.16

	1951 May 9	May 21	June 1	June 12
Rocket	22.5	18.1	15.5	7.3
1/Victory	24.8	22.2	16.0	9.6
Sheyenne	17.7	18.2	16.3	15.5

1/ *The present variety Norland is a selection from Victory.*

**Unpublished data of Dr. W. E. Sackston, Dominion Laboratory of Plant Pathology, Winnipeg.*

The above table indicates that there is usually a marked falling off in yield the later the flax crop is seeded. Moreover, growers agree that, generally speaking, early sown flax is superior not only in yield but also in the quality of the flaxseed produced.

There are, however, occasions when late seeding may be justified. One of these is where drouth or excessive moisture has delayed field work unduly. Again, when wild oat infestation is severe it may pay to work the fields at intervals during April and May to destroy the oats and then to seed the flax. The decision here is: which will cause the greatest loss weeds or late planting?

RATE OF SEEDING

Rate of seeding usually varies from 25 to 40 lbs. per acre. While a somewhat lighter rate of probably half a bushel per acre is recommended on lighter land, on heavier land a higher rate of seed is more desirable and as much as 35 to 40 lbs. per acre is sometimes used. The basic rate may be changed to suit conditions. In addition to the type of soil, some of the conditions which determine how much seed per acre to use include: size of seed, percent germination indicated, the richness or moistness of soil, whether the crop is being seeded early or late and whether the soil is weedy.

DEPTH OF SEEDING

Flax is a small seed. That is why relatively shallow seeding is so important. Tests for seeding flax at depths ranging from 1 to 4 inches show considerable variation as to emergence and strength of plants. For example, in one experiment on a heavy clay loam soil, emergence was 100% at one inch in depth; only 80% emergence at 2 inches and around 25% emergence at 3 inches. The two lower depths of seeding also showed extremely weak plants.

Fields vary in texture and compactness of soil. One of the greatest concerns of the flax grower is getting a good uniform stand and this is something to which uniform germination and emergence both contribute.

A general rule is to sow quite shallow, especially on heavy soil. If possible, flax should never be seeded much below 1 inch in depth on heavy clay soil or much below 1½ inches on light textured soils.

The Use of Fertilizer

Generally speaking, flax has shown little response to fertilizer. In Manitoba, for instance, eight experiments over a period of years have shown that 40 lbs. of ammonium phosphate 11-48-0, drilled in at seeding time, increased flax yields by an average of 1.4 bushels per acre. Calculated as a percentage increase, this is considerably less than that obtained for wheat, oats or barley. Nitrogen is the important factor in increased flax yields and a broadcast application of fertilizer to supply 40 lbs. of nitrogen per acre has shown some results on stubble and even on summerfallow under favorable conditions. It is doubtful, however, if applications over 40 lbs. of nitrogen per acre would produce a sufficiently increased yield to pay; in fact, heavy applications of nitrogen tend to have a depressing effect on the crop.

Authorities suggest that fertilizer placement is an important factor in so far as flax is concerned. Flax is quite susceptible to injury and hence fertilizer should not be drilled in with the seed. Rates which can be applied safely vary greatly with soil texture and soil moisture content.

Other comments on the use of fertilizer with flax suggest that flax sown on stubble land should not be fertilized unless moisture conditions are distinctly favorable. Also mentioned is the fact that, when broadcast, the application of fertilizer may greatly stimulate weed growth. This, however, does not necessarily mean a reduction in yield since, despite the heavier weed growth, there may still be a higher yield of flax.

Flax yields well following legume crops; in fact the flax plant does well if there is an active decomposition of fresh organic matter which releases nitrogen and minerals for the use of the growing plant. If these conditions are provided and if there is ample moisture, little is likely to be gained by the use of commercial fertilizer.

Diseases

With the increase in flax acreage in recent years, it has become important to know more about the diseases of flax. Some of these can be found every year while others appear only in certain seasons. Those caused by disease-producing organisms, seed or soil-borne, can be controlled or reduced in severity by good cultural practices, by care in the selection of the variety or by recommended seed treatments. Others which are the result of climatic conditions are beyond the control of the grower.

Elsewhere in this section there appears a short table showing the main symptoms and the usual methods that are followed in preventing or controlling the common diseases of flax. A somewhat fuller account of the main diseases (excluding 'wilt' and 'rust' against both of which protection is now afforded) is given below.

SEEDLING BLIGHT

This disease may be caused by several different fungi, one of the most prominent of which is 'Rhizoctonia Solani' a soil-borne organism which attacks flax seedlings before or just after they emerge from the ground, destroying tissues at or below the soil surface and resulting in the death of seedlings. It seems to be favored by fairly warm, moist soil and to be most active in well worked land, causing greatest loss to flax sown after summerfallow.

BROWNING AND STEM BREAK

This is a fungal disease of the above-ground parts of the plant. The fungus causing it is seed borne, and lives over the winter in the open or diseased flax residues. It is not usually conspicuous until towards the end of the flowering period when the upper part of the plants may turn brown rapidly. The stems become very brittle and a proportion of the affected plants break off in the region of the first node. The disease occurs frequently in both Alberta and Saskatchewan, although it is rare in Manitoba.

PASMO

This disease, caused by a parasitic fungus, has been found in Manitoba since 1940 and in Saskatchewan since 1946, although it has made little headway yet in Alberta. The disease resembles 'stem break' in several respects, although it does not tend to make affected stems break over near the ground line. The disease causes yellow brown mottled areas on the leaves, stem and seed capsules resulting in pre-mature ripening of the plants. It is more easily recognized as the plants approach maturity when irregular brown areas on the stem

alternate with bands of green. Diseased plants generally occur in groups causing brown patches to show up in affected fields and these patches may enlarge to include the whole field. Pasmo is carried through the winter on the seed and on the straw and stubble on the field. Practically all the common varieties of flax are susceptible to this disease in varying degree although some show moderate resistance. Conditions which favor rust seem to favor pasmo except that it is worse in warm, moist seasons.

HEAT CANKER

While this disease can be found in some prairie flax fields in most seasons, it is only occasionally severe. Unlike many of the other diseases it is not caused by an organism but is a result of weather conditions. It occurs when young flax seedlings are exposed to excessive heat at the soil line, the tender tissues which feed the roots becoming damaged. If the damage is severe, seedlings will fall over and die. If less severe, food accumulates in the stem above the injured area causing them to enlarge or "canker". Seedlings in thin stands on light soil are most subject to injury from this disease. The disease usually occurs when the plants are less than 6 inches in height, although plants damaged earlier may survive only flowering.

ASTER YELLOWS

This disease was first recognized as being fairly widespread on flax in farm fields in 1953. During 1957, it was widely prevalent and quite destructive in Manitoba and present, though less destructive in both Saskatchewan and Alberta. It may become less important or even disappear if there is a series of years unfavorable to the weed hosts of the virus and the leaf hopper that carries it. Symptoms include yellowing of the upper part of the plant and distortion of the flowers. The petals may be greenish purple instead of blue and may remain on the plant instead of falling a few hours after the flowers open as they do on normal plants. The most typical symptom is the occurrence of green to yellowish or purple leaf-like structures in place of the usual petals and other flower parts. On some plants, all flowers may be affected; on others only some flowers. The severity of symptoms depends on the stage at which plants are affected. If they are very young, they may be stunted and produce no flowers at all. Infection a little later may cause distortion and sterility of all or most of the flowers, although the plants may reach normal size. Later still infection may cause symptoms on only some of the flowers. Where infection is too late to bring about abnormalities in the flower, the seed size and weight may be reduced. Frequently seeds produced on plants affected by this disease do not germinate.

DISEASES OF FLAX

NATURE OF DISEASE AND SYMPTOMS

		PREVENTION or CONTROL
SEED OR SOIL BORNE		
Root Rot	An adult plant symptom caused by some of the same organisms as those responsible for wilt. Plants show slight stunting with premature ripening of the plant and shrivelling of the seed.	Treat seed with recommended chemical.
Seedling Blight and Damping Off	Caused by several different fungi. Seedlings may fail to emerge. Seedlings 1 to 4 inches high wilt and die. Reddish brown patches are found on roots and stems below the soil.	Sow only sound clean seed. Sow early and shallow. Seed should be treated with recommended chemical.
Seed Rot	Caused by fungi which attack cracked seed or seed which has suffered mechanical injury. This disease comes close to being a pre-emergence seedling blight.	Sow only sound clean seed and treat with recommended chemical.
Wilt	Plants may wilt, die and turn brown at any time from the seedling stage on. The top of the stem curves down. In some cases, growth stops and the plant turns yellow or greyish in colour.	Use resistant varieties and follow a suitable crop rotation.
SEED BORNE OR CARRIED ON FLAX RESIDUES		
Browning and Stem Break	Affects the flax plant above ground, usually towards end of the flowering period. Upper part of plants turn brown with brown spots appearing on seed stems and seed bolls. Stems become brittle and a breaking over of the plants about 1 inch above ground level is apparent.	The use of clean seed in soil free from and well removed from diseased flax straws. Do not sow flax after flax.
Pasmo	Resembles browning in some respects and occurs late in season. Irregular brown spots appear on leaves and bolls. Large brown patches on stems often alternate with green areas giving mottled appearance.	Avoid the most susceptible varieties. Sow early and do not follow flax with flax.

AIR BORNE AND CARRIED ON FLAX RESIDUES

Rust	Small round orange pustules appear on leaves, especially the lower ones, and in severe cases the leaves fall. Elongate black pustules appear on the stems as plants mature.	Sow resistant varieties. Practice crop rotation so as to avoid following flax with flax. Early seeding may help to reduce injury.

INSECT BORNE

Aster Yellows	Symptoms include yellowing of the upper part of the plant and distortion of the flowers. Petals may be greenish purple instead of blue and may remain on plant. Typical symptom is the occurrence of green to yellowish or purple leaf-like structures in place of the usual petals and other parts. Severity of symptoms depends on stage at which plants are affected. If young, they may be stunted and produce no flowers at all. Later infection may cause distortion and sterility of all or most of the flowers, although the plants may attain normal size. Still later, only some of the flowers may be infected.	As this disease is carried by an insect, not much can be done about it. Weeds in and near flax crops, however, should be destroyed since some of these may carry the same virus that attacks flax.

PHYSIOLOGICAL

Heat Canker	A direct result of high temperatures at the soil line. Outer tissues of affected plants collapse and the plants fall over and die. Generally occurs when plants are 5 to 6 inches high. Partially affected plants often continue to grow but are constricted at or near the soil surface and cracks or "cankers" will appear above the injured area.	Early seeding at a fairly heavy rate in a north and south direction, to provide shade at mid-day.
Top Die-Back	Usually top third but sometimes the whole plant turns brown following hot dry weather during the ripening period.	Early seeding to mature crop earlier and to prevent heat damage late in summer, may help.

Weed Control

GENERAL COMMENTS

Flax is much less able to compete with weeds than are wheat, oats and barley due mainly to the fact that the flax plant does not shade the ground to the same extent during the growing season. The flax plant, too, has a less vigorous and extensive root system and cannot make as efficient use of plant food and moisture within its area of growth. For these reasons, the most fertile, as well as the **cleanest possible land** should be provided for this crop if satisfactory yields are to be obtained.

If the land is clean, maximum yields will be secured from early seeding but in cases where it is necessary to delay planting to permit Spring tillage for wild oat control, early maturing varieties should be used.

FLAX ON SUMMERFALLOW AND STUBBLELAND

Land that has been inter-tilled the previous year usually presents less of a weed problem and produces satisfactory crops of flax. Summerfallow on which moisture has been conserved is generally the most productive land. There is, however, a danger that where summerfallow has been poorly worked, many weed seeds such as mustard, stinkweed and lamb's quarters will lie dormant and germinate the following year. Flax being a poor weed competitor does not outgrow these weeds as do wheat, oats and barley; this is the reason that flax grown on summerfallow is often a weedy crop. If on the other hand, weeds have been readily controlled, summerfallow is probably the best place for flax because the land will contain more moisture.

Land that has produced a grain crop the year before, if lightly worked to make a seedbed, is often much more free of weeds than is summerfallow. Where flax is sown on stubble land a recommended practice has been to disk the land lightly in the fall soon after harvest, unless there is danger of soil drifting. This operation tends to start many weeds at that time. Where no fall cultivation has been done, the land can be disked early in the Spring, two to three weeks being allowed for the weeds to make a good start and the seeding of flax being delayed until towards the end of May.

CHEMICAL CONTROL

Because most weeds can now be readily controlled by herbicides, the weed problem in flax is not as serious a matter as it once was.

Two chemicals are generally recommended for the treatment of broad leaved weeds in flax: 2,4-D and MCPA. Of the two, however, there is almost complete agreement that even when the dosage exceeds that of 2,4-D, MCPA is less harsh on flax. Flax, while usually showing a weakening of above ground parts following the application of even moderate doses of 2,4-D, especially the ester formulation, seldom fails to make satisfactory recovery although there is usually some delay in ripening from a few days to at times as much as two weeks. Substituting MCPA tends to overcome this hazard to a great extent and reduces delay in maturity. Under some conditions, the choice between 2,4-D and MCPA is not easy. Under the present price differential, when increased dosage is considered, the acre cost for materials favors 2,4-D. At the same time, provided MCPA will control the weed problem, the increased yields that may be anticipated should more than offset the additional cost as compared with 2,4-D.

Where either 2,4-D or MCPA is used, treatment should be made from the time the plants reach a height of about two inches (or the three leaf stage) up to just before the pre-bud stage, and to obtain the best results, as soon as there is enough emergence of susceptible weeds to make spraying practicable. In its recommendations for 1957, the National Weed Committee (Western Section) points out that there may be some reduction in yield from flax treated with 2,4-D or MCPA unless weed competition is reduced enough to compensate from any injury resulting from the treatment. It adds that flax is more tolerant to MCPA formulations and the amine salt of 2,4-D than to an ester of 2,4-D. However, for control of the more resistant types of weeds an ester of 2,4-D should be used, with some damage to flax to be expected. Recommended rates of applying 2,4-D and MCPA in water spray for post-emergent control of weeds in flax are as follows: (in acid equivalent per acre)

OUNCES ACID EQUIVALENT PER ACRE

Formulation	Weed Group I (Very Susceptible)	Weed Group II (Susceptible Annuals)	Weed Group III (Moderately Susceptible)	Weed Group IV (Moderately Resistant)
MCPA*				
Ester	3 to 4	4 to 6	(6 to 8)	(9 to 12)
Amine	4 to 5	5 to 7	(7 to 9)	(10 to 14)
Sodium salt	5 to 6	6 to 8	(8 to 10)	(12 to 15)
2,4-D**				
Ester	3 to 4	(4 to 6)	(6 to 8)	
Amine	4 to 5	(5 to 7)	(7 to 9)	

* Under certain conditions the higher rates (in brackets) may cause injury to the flax crop, but this will frequently be offset by obtaining a higher relative yield from a less weedy crop.

**Considerable damage to the flax should be expected, especially at rates higher than six ounces of ester and 7 ounces of amine.

While it is not possible to include here a complete classification of weeds indicating their response to 2,4-D or MCPA the following partial list may be valuable as a guide:

Group I	Very Susceptible:	Wild Mustard
Group II	Susceptible Annuals:	Lamb's quarters, Ball Mustard, Tumbling Mustard, Ragweed, Stinkweed
Group III	Moderately Susceptible:	Blue Bur, Cocklebur, Russian Pigweed, Shepherd's Purse
Group IV	Moderately Resistant:	Field Bindweed, Wild Buckwheat, Tartary Buckwheat, Red Root Pigweed, Sow Thistle (annual), Canada Thistle, Tumbleweed.

To control green foxtail in flax the sodium salt of TCA at 4 to 6 lbs. acid per acre may be used. This should be applied during the period from the time the weed emerges until it is two inches tall. TCA may also be combined with MCPA or 2,4-D at the recommended rates for these herbicides to control both green foxtail and broad-leaved weeds with the one application.

Harvesting and Threshing

Flax should be cut when the greatest possible ripening has been obtained. In wet seasons or when fields have been sown late, second growth is a problem and plants will continue to bloom until well into the fall. Under these circumstances it is a matter of judgement as to when the largest amount of ripe seed may be obtained. Experience has shown, however, that more often a better crop will be harvested reasonably early in the ripening season than towards the end of the season. As yet, the use of chemical desiccants to hasten maturity and the drying of the stems has not developed to the point where it is feasible, but this is a future possibility.

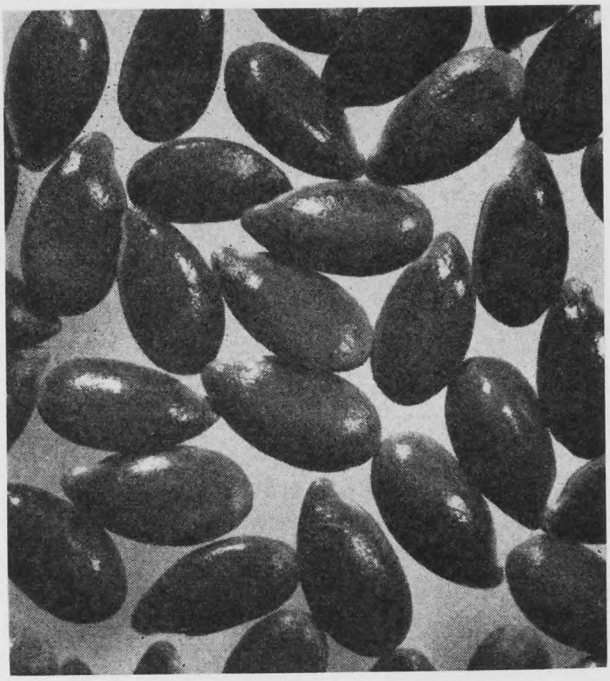
Although windrowing and use of the pickup on the combine is the most familiar method of handling flax, it may be straight combined, if it is well matured and has ripened evenly. It is a fairly common practice to harvest flax after a frost which tends to dry up the plants and weeds and also hardens the flax bolls so that they are more easily shattered. This practice will depend upon fall conditions as well as upon the cleanness of the crop. It may, however, at times, be a risky procedure, especially if it is necessary to wait until late in the fall for a killing frost to occur.

WINDROWING

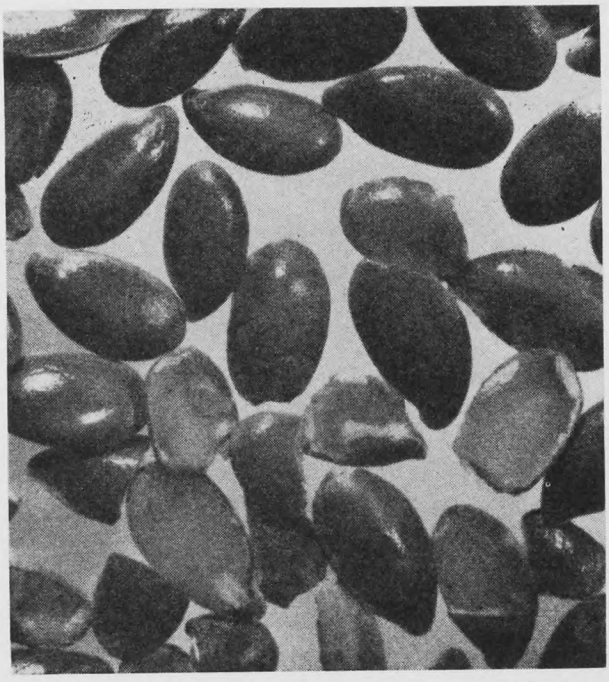
If harvested before a frost, particularly if the crop is weedy, flax usually requires windrowing to dry the flax plants, bolls and weeds, the accepted practice being to swath when 75% or better of the bolls are mature. When the crop is swathed, several precautions should be taken to make as effective a job as possible. Green, immature flax straw may give trouble in collecting under the knife and when this happens the use of a smooth-sectioned knife will usually overcome the trouble. Flax windrows are easily blown by high winds and this problem may be overcome by trailing a light windrow packer behind the swather. Very satisfactory for this purpose is a metal float or a one-half inch pipe axle centered in a light gauge oil drum and fitted into a wooden frame to form a hitch. The weight of the oil drum packer rolling on the windrow will depress the flax into the stubble sufficiently to prevent wind damage provided the wind is not blowing at the time. The height of cutting with a swather will vary with the height of the crop but in a crop of average height, leaving one-third as stubble and two-thirds in the windrow is recommended, although in shorter or thinner stands less stubble will have to be left so that the crop may be handled by the pickup. Generally speaking, a 4 to 6 inch height of cut provides sufficient stubble to hold flax windrows off the ground. Windrowed flax, as a rule, will retain its brightness and colour after wheat, oats and barley have become badly bleached and discoloured.

COMBINING

If free from weeds and mature, flax makes a good straight combine crop because it does not shatter easily. The seed is enclosed in tight bolls and since



Sound Flax, Well-Matured and Uniform. Grading 1 C.W.



Well-Matured Flax degraded on account of broken and damaged kernels.

—Courtesy Board of Grain Commissioners, Grain Research Laboratory, Winnipeg.

it does not sprout readily or show weather damage it may be left in the fields unthreshed much longer than cereals.

Because many factors enter into the successful combining of flax, experts suggest that it is not easy to outline definite adjustments and procedures. Aside from the different threshing action needed for some varieties, these factors include varying harvest weather conditions, changes in the humidity of the air and the way the crop has matured—all of which may call for changes and adjustments several times daily if threshing is to be done without damaging the seed. Two general rules, however, should be mentioned:

(1) **Flax should not be threshed until moisture content is down to 10.5%,** unless because of unfavorable weather late in the fall, it becomes absolutely necessary to proceed with the harvest.

(2) **No attempt should be made to do a "Seed" job with the combine.** If a heavy, really clean sample is obtained, it almost always carries with it a large percentage of damaged seeds. Flax is easily injured in threshing and cracked or scratched seed, even though invisible to the eye, permits the entry of some form of mould. Broken and chipped kernels, too, cause trouble in processing. Cylinder speed and concave clearances are all important in minimizing damage of this kind.

CYLINDER SPEED AND CLEARANCE

Cylinder speed should be in the same range as that required for threshing wheat, that is, the tip of the cylinder bars or teeth should run at approximately 6200 feet per minute. Speed should be kept to a practical minimum, however, to reduce the danger of damaging the seeds and at the same time to obtain the desired degree of threshing. When rubber rolls are used, the cylinder speed may be reduced to as low as 5800 feet per minute at the circumferences. Authorities suggest that the bar type of cylinder has generally proven superior to the tooth type for threshing all oil seed crops, including Flax.

Clearance between the concaves and the cylinder at the front should be approximately half that required for wheat, ranging from 1/8 to 1/4 or even 5/16 of an inch, depending upon threshing conditions. The rear clearance, also adjusted according to threshing conditions, may range from 1/16 to 1/8 of an inch. The object should be to have the concave clearance set up close enough to break the flax bolls in the first pass through. Shredding of the straw, breaking of the kernels, large amounts of broken straw in the grain or a heavily overloaded shoe usually indicate insufficient clearance resulting in too severe a threshing action. On the other hand, unbroken bolls, or a heavy return of bolls not stripped from the straw indicate too much clearance.

OTHER ADJUSTMENTS

The separation of large amounts of chaff from the seeds is difficult. The wind blast from the fan should be reduced to considerably less than that required for the cleaning of wheat. This may be done by either reducing the fan speed or closing the air intake shutters on the fan housing, or a combination of both.

The chaffer sieve should be as wide open as possible to allow the maximum quantity of grain to pass through, thus preventing a heavy return. The wind board located behind the fan in most combines, should be set to direct the air blast well towards the front of the shoe so that all flax and chaff will be lifted off the chaffer surface. Sufficient air blast will then be available on the back 2/3 of the shoe to float the chaff over the tailings grate yet permit the separated grain to fall onto a clean chaffer surface and pass through to the grading or cleaning sieve.

The final cleaning sieve in the shoe may be an adjustable sieve or a round hole non-adjustable type, depending on the type of the combine. The adjustable type sieve should be nearest to the point where it will allow the flax seed to pass through and will float unbroken or partially broken bolls and short stems over into the return auger for re-threshing. The non-adjustable type should be a 9/64 to 3/16 inch diameter round hole sieve, depending on the plumpness of the flax.

Grades

Flaxseed carries 4 statutory grades, details of which are given below

STATUTORY GRADES

STANDARD OF QUALITY

FLAXSEED

	MIN. WGHT. PER BUS.	SOUNDNESS	STANDARD OF CLEANNESS
1 C.W.	51	Matured and sweet. May contain 12½% damaged seeds, including broken seeds.	Clean, commercially pure seed.
2 C.W.	50	Matured and sweet. May contain 25% damaged seeds, including broken seeds.	Clean, commercially pure seed.
3 C.W.	47	May contain 5% heat damage.	Clean, commercially pure seed.
4 C.W.	44	May contain 10% heat damage.	Clean, commercially pure seed.

Flax and Broken Grain—Shall be composed of flax mixed with broken grain of any description that cannot be classified under any established grade, flax predominating.

Flaxseed weighing less than 44 lbs. per bushel will grade "Sample C.W. Flaxseed a/c light weight."

GRADING FACTORS

Percentage of Moisture Allowed in Straight, Tough or Damp Grain

Straight Grade: Up to 10.5%.
Tough: 10.6% to 13.5%.
Damp: Over 13.5%.

Sample Flax:

1 C.W. and 2 C.W. containing up to 5% heated, grades 3 C.W.

1, 2 and 3 C.W. containing up to 10% heated, grades 4 C.W.

All flaxseed that does not qualify for a statutory or commercial grade or an off-grade, is graded as "Sample" with the addition of words to indicate damage or admixtures.

Off Grades

All Western flaxseed containing excessive admixtures, but not exceeding two and one-half percent of broken grain or Lady's Thumb that cannot be readily removed, grades according to the grade requirements of the statutory grades applicable to such flaxseed if it did not contain such excessive admixtures, and there is added to, and made part of the grade name the word "Rejected" and words to indicate the excessive admixture — for example: "Rejected No. 1 C.W. Account Lady's Thumb".

Per Cent of Broken Grain Allowed

The percentages of broken grain allowed in the grades are as follows:—

1 C.W.	Free of Broken Grain
2 C.W.	May contain ¼% of Broken grain
3 and 4 C.W.	May contain ¾% of Broken grain

Cereal Grain Admixtures

Flax containing 2½% and over of cereal grain or mixture of cereal grain, grades C.C. (Clean till clean). Wild oats in flax are classed as dockage.

Flaxseed Containing False Flax

1 C.W.	may	contain	5%	False	Flax
2 C.W.	"	"	10%	"	"
3 C.W.	"	"	15%	"	"
4 C.W.	"	"	25%	"	"
"Sample"	when	over	25%	"	"

Storing

Flax is one crop which cannot be stored safely if the moisture content is high; that is, over 10.5%. If the moisture is above this level, it will pay to clean the flax and to remove all foreign moisture and weed seeds. This will help to reduce the moisture content considerably but it will still be advisable to examine the flax very carefully, from time to time, for indications of heating.

Some General Observations

No attempt has been made in this bulletin to discuss such matters as the place of flax in the rotation or to go into any detail about cultural practices. These are matters which are related to soil, rainfall, weed control problems, the type of crops best suited to the area and other factors. The local District Agriculturist or authorities at the nearest Experimental Farm are in a better position to discuss these matters with the individual producer.

In general, however, it may be said that flax will fit into almost any cropping plan and that it may prove useful in a rotation for at least two reasons. First, it is not subject to the common diseases of the other crops and for this reason it offers a good alternative to them; and second, it has long been accepted as the best nurse or companion crop for a new seedling of legumes and grasses.

The long time average yield of flax for the prairie provinces is close to 8 bushels per acre or approximately half that of wheat. During 1957, because of the "aster yellow" disease and drouth, the average yield in the prairie provinces was only 5.7 bushels per acre and that for Manitoba as low as 4 bushels per acre. Disappointment at the performance of flax last year may lead to some reduction in acreage during 1958; however, as long as the outlook for the marketing and sale of flax remains good it is probable that the interest in this crop will be well maintained. As a reliable 'cash' crop flax appears to have gathered strength in recent years and, generally speaking, it has given a very good account of itself.

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